

area affected. This condition improved very slowly; some highways were not opened to traffic until the end of February. In the vicinity of Sheboygan automobiles were not able to get through until the last week in March.

The interests most seriously affected by the storm, however, were the overhead wire companies. In southern and southeastern Wisconsin the precipitation began on February 3 as a light misting rain which turned to sleet and snow during the night, the temperature being slightly below the freezing point. All exposed objects were covered with glaze. In Milwaukee the coating of ice averaged about $\frac{1}{8}$ inch in thickness, but the telegraph and telephone companies report that at some other points the coating of ice on wires was $\frac{1}{2}$ to $\frac{3}{4}$ inch in diameter. This ice together with the high winds caused the breakage of large numbers of telegraph and telephone poles and the prostration of many miles of wire. One company alone reported 924 poles broken, 480 miles of wire destroyed, 11,000 wire breaks, and 3,800 miles of wire to be repulled and retied to insulators. Their monetary loss was \$172,000.

Because of broken wires, etc., the toll-line circuits of the telephone companies began to fail soon after midnight February 3-4, and most of them were out of order by 7 a. m. the 4th. Over most of these lines service was restored by the afternoon of the 9th, but in several localities it was interrupted for 10 days, and one of the larger companies expected that permanent repairs would not be completed until May 1.

From all available data it is estimated that the actual property loss from the storm was approximately \$231,000, but the economic loss from delayed traffic of all kinds was much greater.

TORNADO IN NORTH TEXAS ON APRIL 3, 1924¹

A tornado was observed in Denton County, Tex., near the village of Justin about 4 p. m. April 3, 1924. It moved thence in an east-southeast direction through the northeast corner of Dallas County, the northern end of the adjoining county of Kaufman and was last observed about a mile southwest of Edgewood in Van Zandt County, having traveled a distance of about 80 miles in four hours. The tornado passed over a thinly settled district and for a part of its course the funnel cloud was not in direct connection with the ground. One person was killed and 14 injured and property loss of about \$40,000 was sustained.

The meteorological conditions at the Dallas Weather Bureau station, when the tornado passed to the eastward about 12 miles directly north of the station, were not unusual or striking in any respect. The barometer fell from 29.88 inches at 8 a. m. 75th meridian time to 29.72 inches at 5:45 p. m. and then rose sharply 0.03 inch.

Hail fell in the path of the tornado in Denton, Rockwall, and Dallas Counties. There was but little thunder and lightning. The width of the tornado's path was about 1,000 feet and that of the hail fall from $\frac{1}{2}$ to 2 miles.

The usual number of freaks, such as straws being driven into wood, etc., were observed.

¹ Condensed from a report by J. L. Cline, Meteorologist, Weather Bureau Office, Dallas, Tex.

NOTE ON PARTIAL CORRELATION¹

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At the time that Doctor Walker commenced his researches on seasonal correlations², the modern form of the theory of multiple linear correlation was new³, and in large part he developed his own notation and methods. Walker's method of deriving the total correlation coefficient and the regression equation differs from that expounded in the textbooks of statistics, yet it apparently entails less arithmetical labor, and should be more widely known than it is.

If a variable quantity X_1 depends upon a number of other variable quantities X_2, X_3, \dots, X_k , then we may look upon the successive variations of X_1 from its arithmetic mean as made up of (1) portions due to the variations of X_2 from its arithmetic mean, and (2) remainders, independent of X_2 , due to the variations in X_3, \dots, X_k , and more or less of the nature of accidental errors. Under these circumstances, if we assume a linear relation between the variations x_1 from the mean of X_1 and the variations x_2 from the mean of X_2 , the Theory of Least Squares gives for the "best" representation of the relationship.

$$x_1 = r_{12} \frac{\sigma_1}{\sigma_2} x_2 \quad (1)$$

in which the so-called correlation coefficient

$$r = \frac{\sum(x_1 x_2)}{N \sigma_1 \sigma_2} \quad (2)$$

expresses the proportionate extent to which the variations in X_1 are determined by, or related to, those of X_2 . Similarly, if we wish to determine the extent to which the variations in X_1 are due to those in X_2, X_3, \dots, X_n jointly, exclusive of the effects of X_{n+1}, X_{n+2}, \dots , we have, assuming a linear relation

$$x_1 = a_{12}x_2 + a_{13}x_3 + \dots + a_{1n}x_n, \quad (3)$$

where, in the case of four variables for example, as Walker has shown

$$a_{12} = \frac{\sigma_1 \{ r_{12}(1 - r_{24}^2) + r_{13}(r_{24}r_{34} - r_{23}) + r_{14}(r_{23}r_{34} - r_{24}) \}}{\sigma_2 \{ 1 - r_{23}^2 - r_{24}^2 - r_{34}^2 + 2r_{23}r_{34}r_{24} \}}, \text{ etc.,} \quad (4)$$

while the "effective correlation coefficient" is

$$m = \frac{1}{\sigma_1} \sqrt{[a_{12}\sigma_2r_{12}\sigma_1 + a_{13}\sigma_3r_{13}\sigma_1 + a_{14}\sigma_4r_{14}\sigma_1]}, \quad (5)$$

and expresses the proportionate extent to which the variations in X_1 are governed by those in X_2, X_3, X_4 .

¹ Presented as part of the discussion on Dr. G. T. Walker's method of making monsoon rain forecasts, Weather Bureau staff meeting of Apr. 16, 1924.

² G. T. Walker. Correlations in Seasonal Variations of Climate, *Mem. Ind. Met. Dept.*, Vol. XX, pt. 6, 1909; Correlation in Seasonal Variations of Weather, II, *Mem. Ind. Met. Dept.*, XXI, pt. 2, 1910; III, XXI, 9, 1914; IV, XXI, 10, 1915; V, XXI, 11, 1915; VI, XXI, 12, 1915; VII, XXIII, 2, 1922; VIII, XXIV, 4, 1923.

³ G. U. Yule. On the Theory of Correlation for any Number of Variables, Treated by a new System of Notation. *Proc. Roy. Soc.*, A79, 182-193, 1907.